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(54) **LENS BARREL**

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G02B 7/02	(2006.01)
G03B 5/02	(2006.01)
G02B 5/00	(2006.01)
G02B 27/00	(2006.01)

(52) **U.S. Cl.**

CPC ***G02B 7/02*** (2013.01); ***G02B 5/005*** (2013.01); ***G02B 27/0018*** (2013.01)

(58) **Field of Classification Search**

CPC G03B 11/04; G03B 17/12; G03B 23/16; G03B 7/02; G03B 5/005; G03B 27/0018

USPC 359/611, 826, 827, 830

See application file for complete search history.

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(57) **ABSTRACT**

A lens barrel includes a rectilinear unit, a lens unit, and a light shielding member. The lens unit is arranged inside the rectilinear unit and is movable relative to the rectilinear unit in an optical axis direction. The light shielding member functions for light shielding between the rectilinear unit and the lens unit. The light shielding unit has a light shielding layer and a support layer. The shielding layer is fitted on a decoration frame of the lens unit and closes a gap defined between the rectilinear unit and the lens unit and extending in the optical axis direction. The support layer has a body bonded to the light shielding area. The body has at least one low rigidity portion. The low rigidity portion has rigidity lower than that of the body.

14 Claims, 13 Drawing Sheets

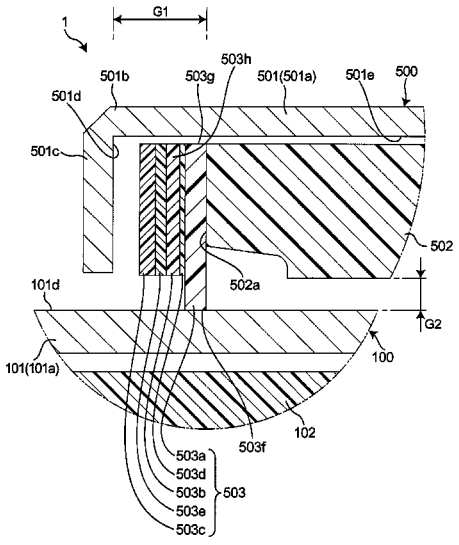

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Fig.1

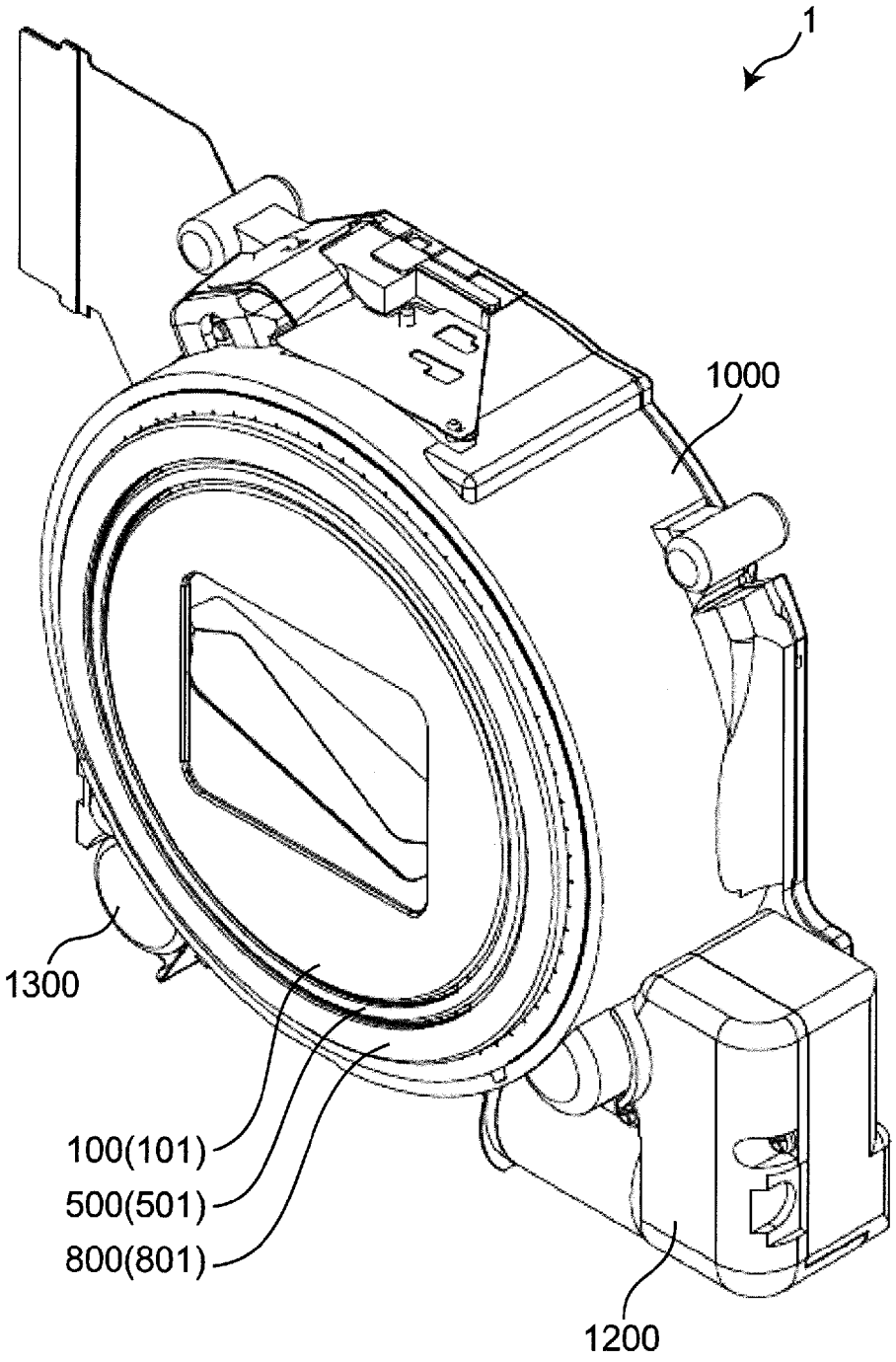


Fig.2

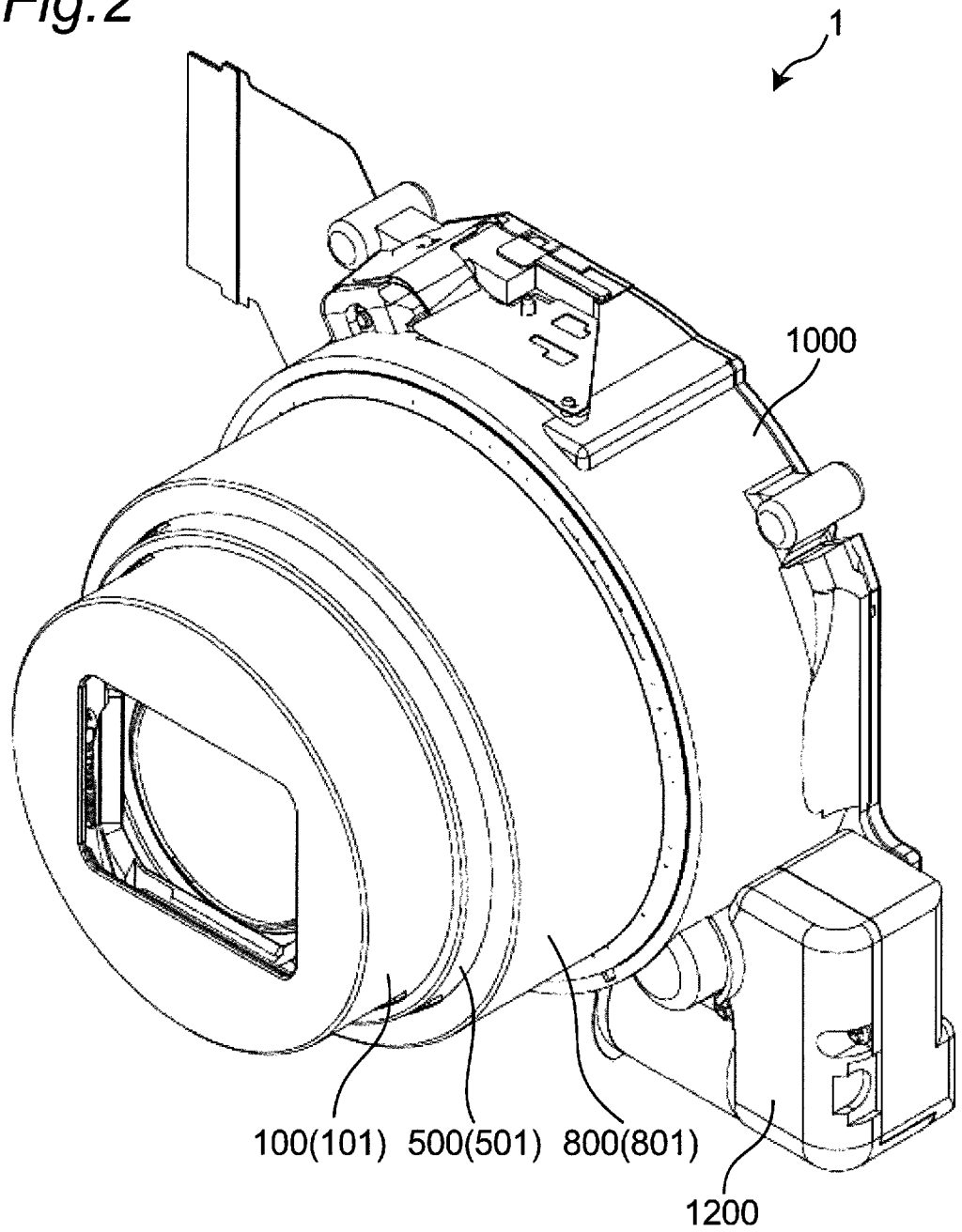
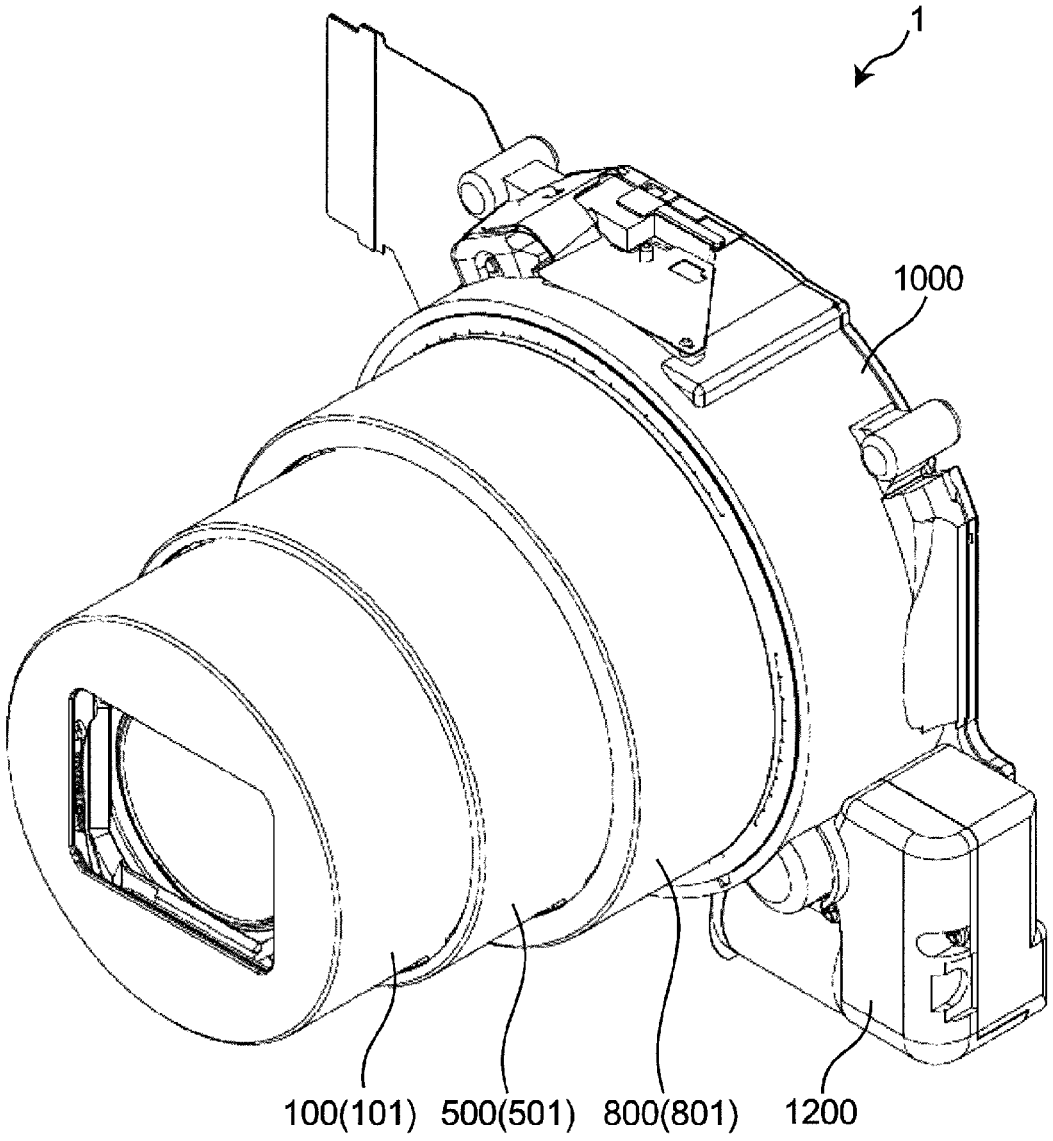
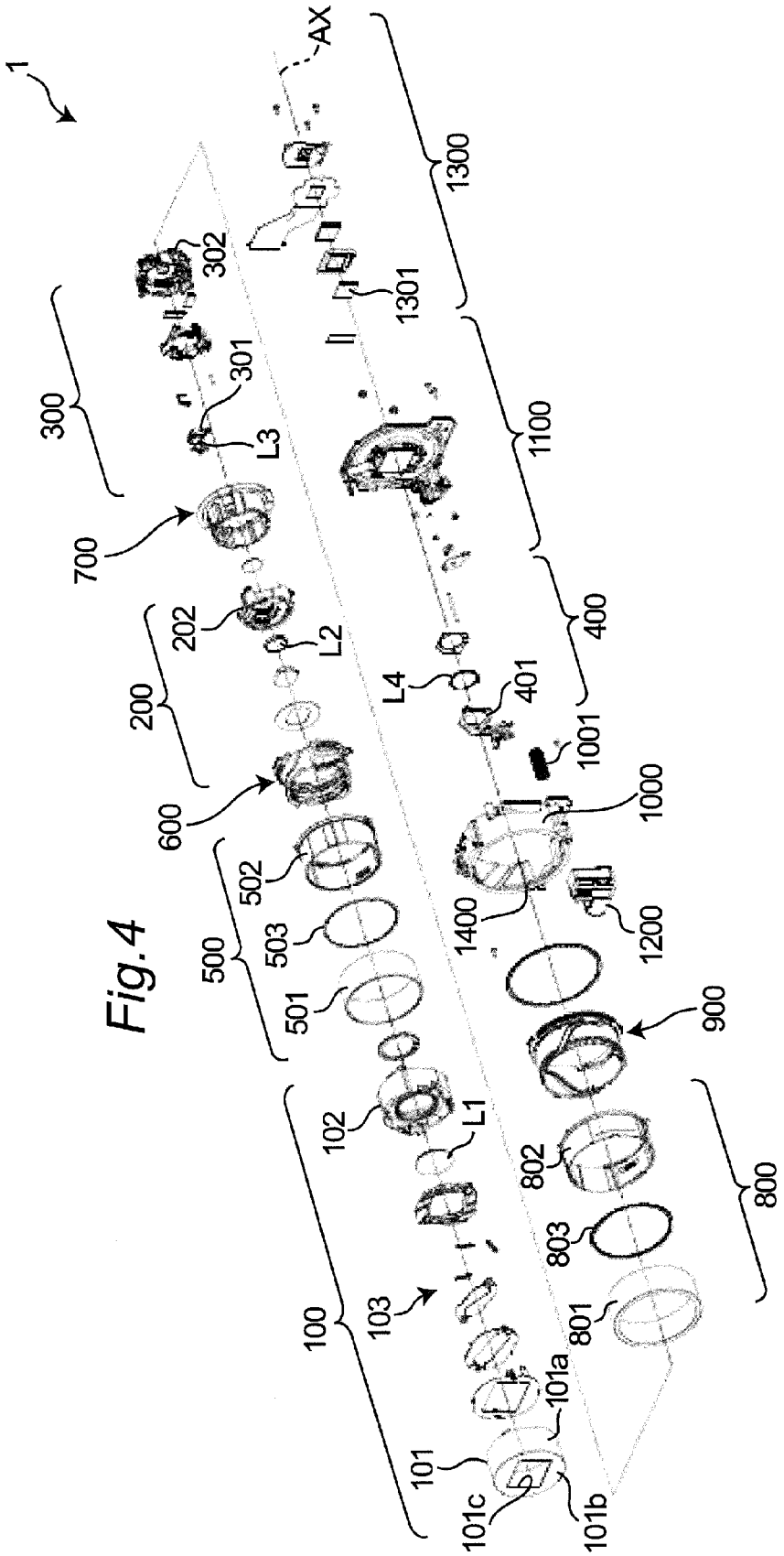


Fig.3

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AX
1300
1301
302
301
300
L3
700
1100
202
200
L2
L4
401
400
1001
600
1000
502
503
500
1400
1200
501
900
102
L1
802
803
800
103
100
801
101a
101
101c
101b

Fig.4

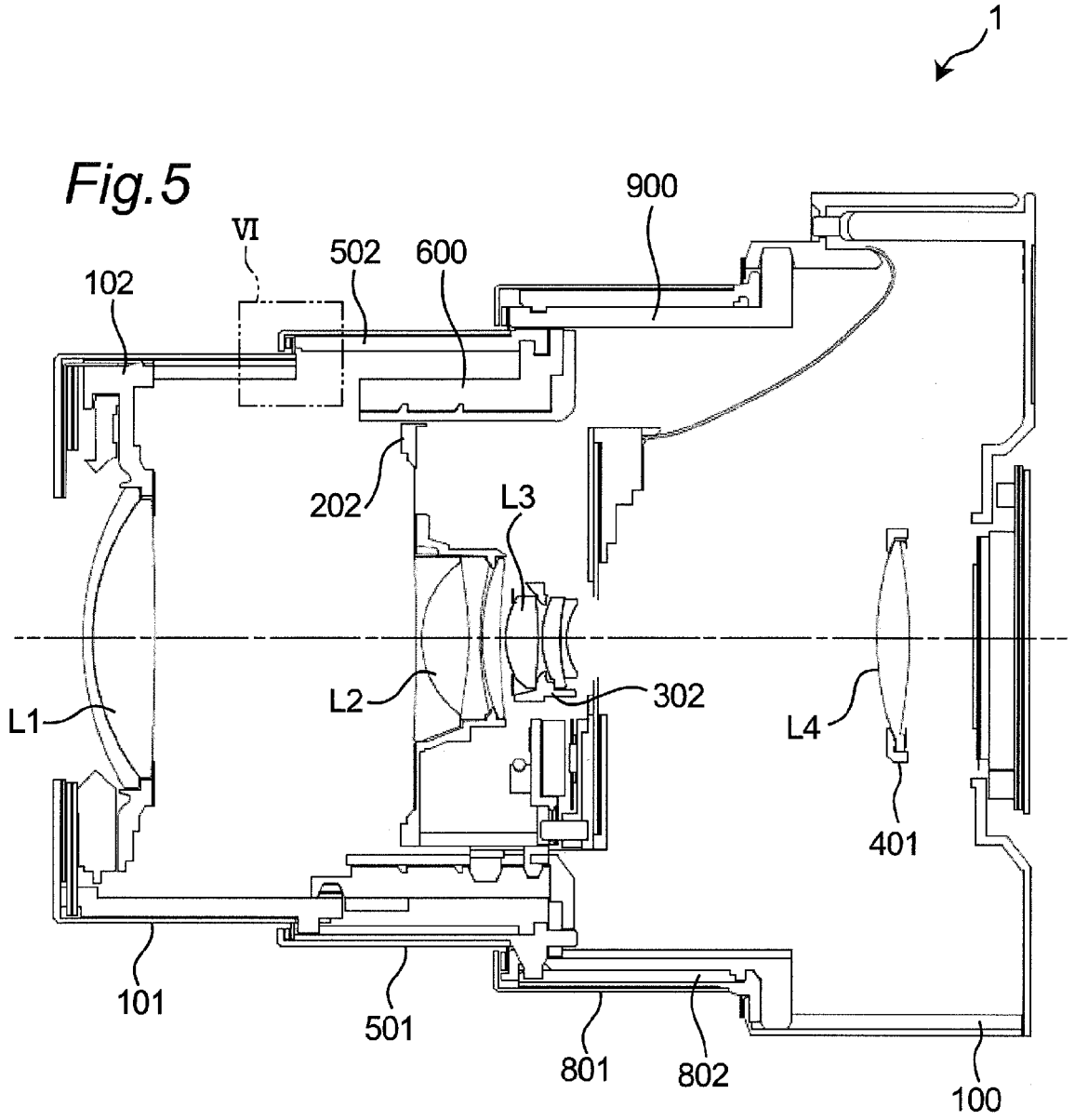
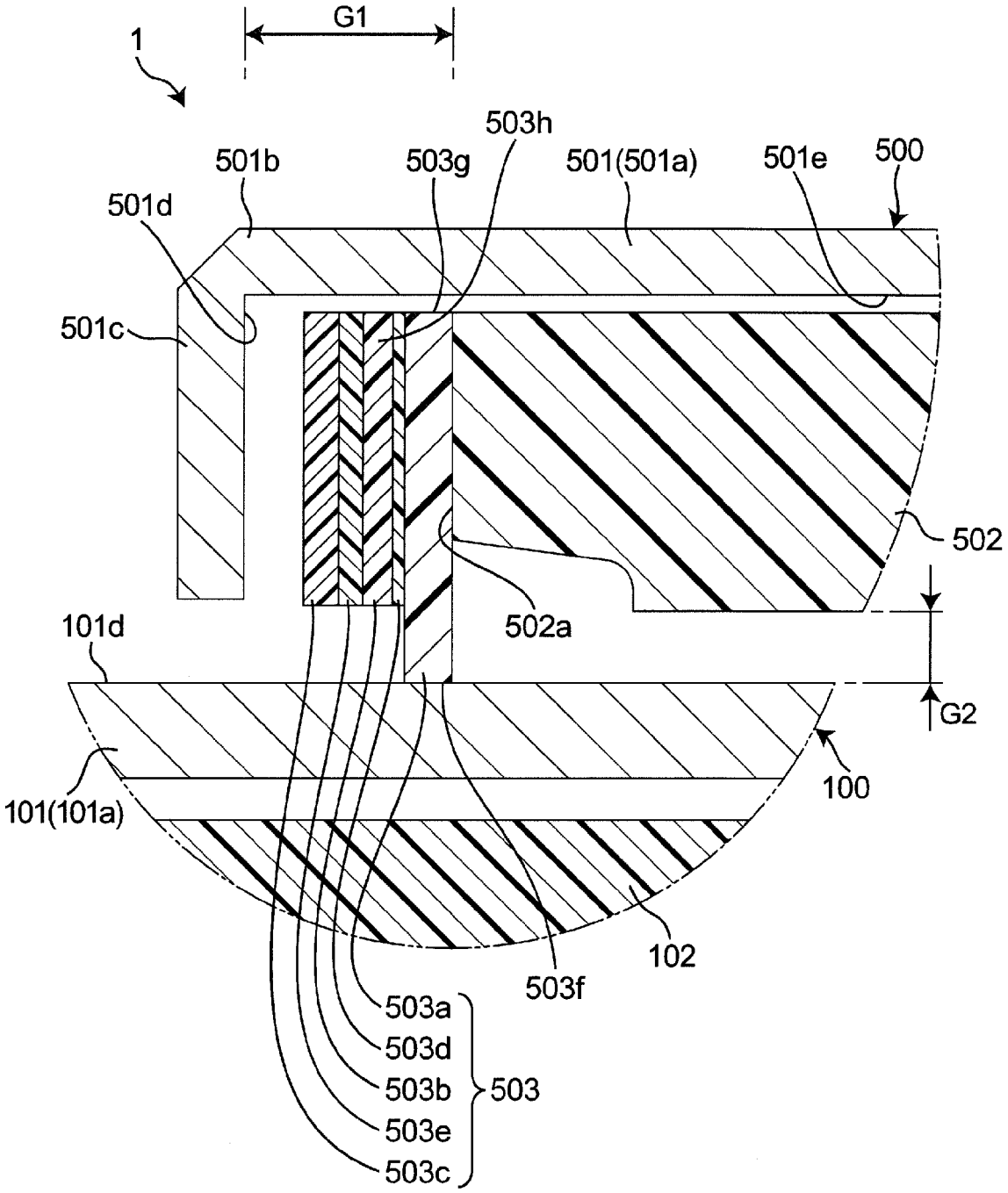


Fig.5

Fig.6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501b
503g
501(501a)
501e
500
501d
501c
502
502a
101d
G2
100
101(101a)
102
503f
503a
503d
503b
503
503e
503c

Fig.7

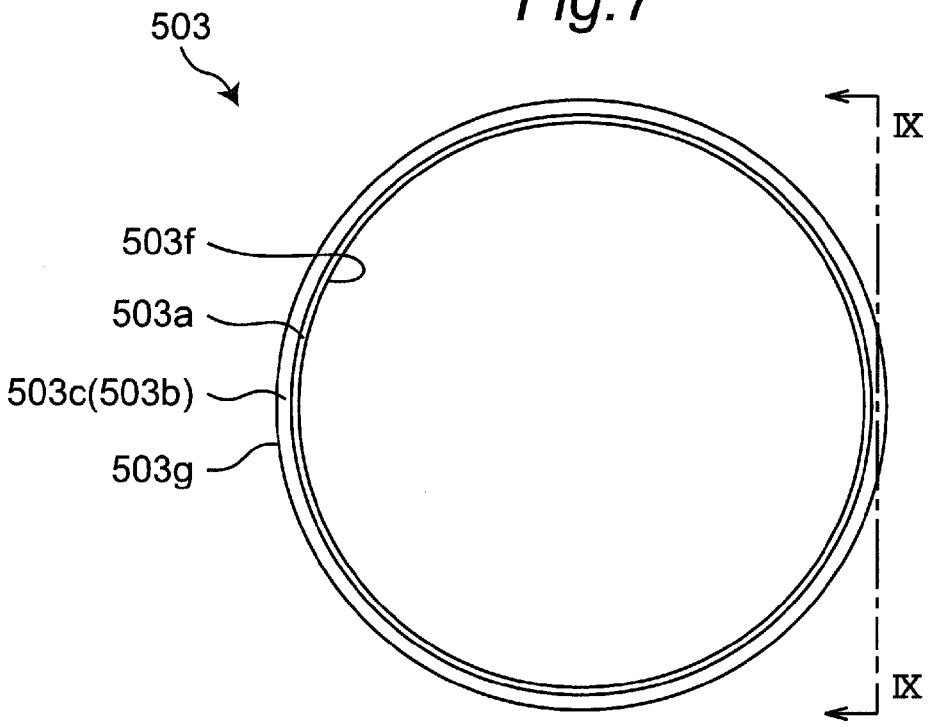


Fig.8

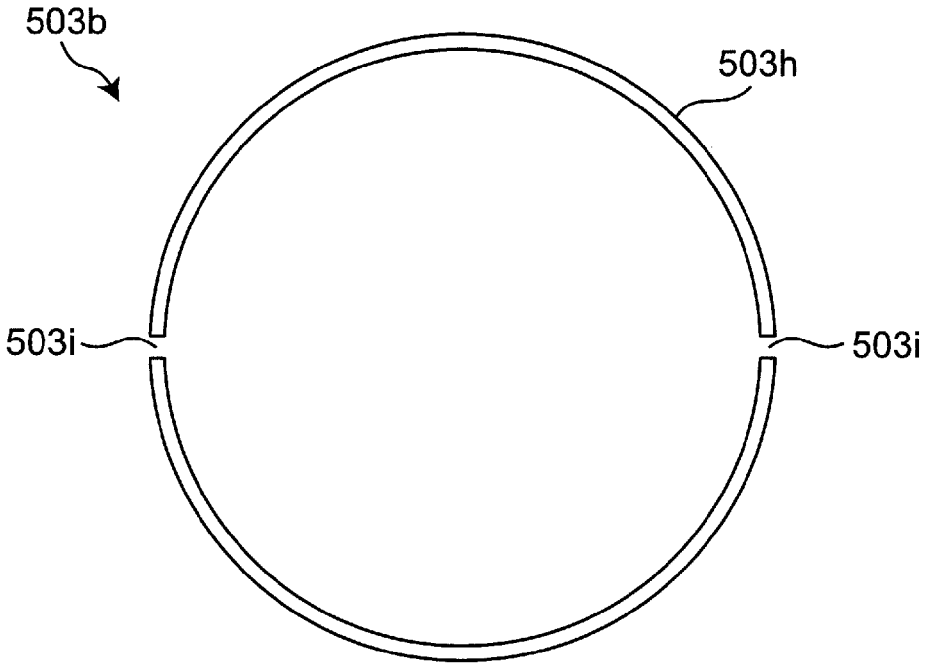


Fig.9

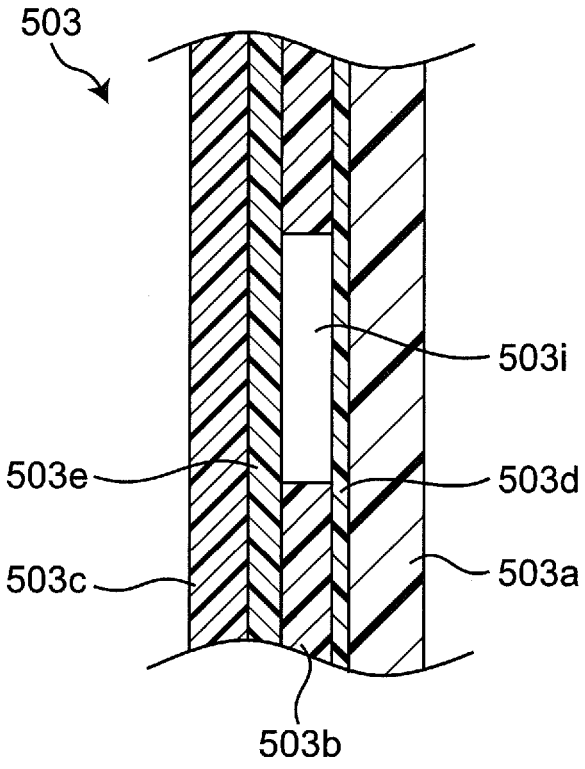


Fig.10A

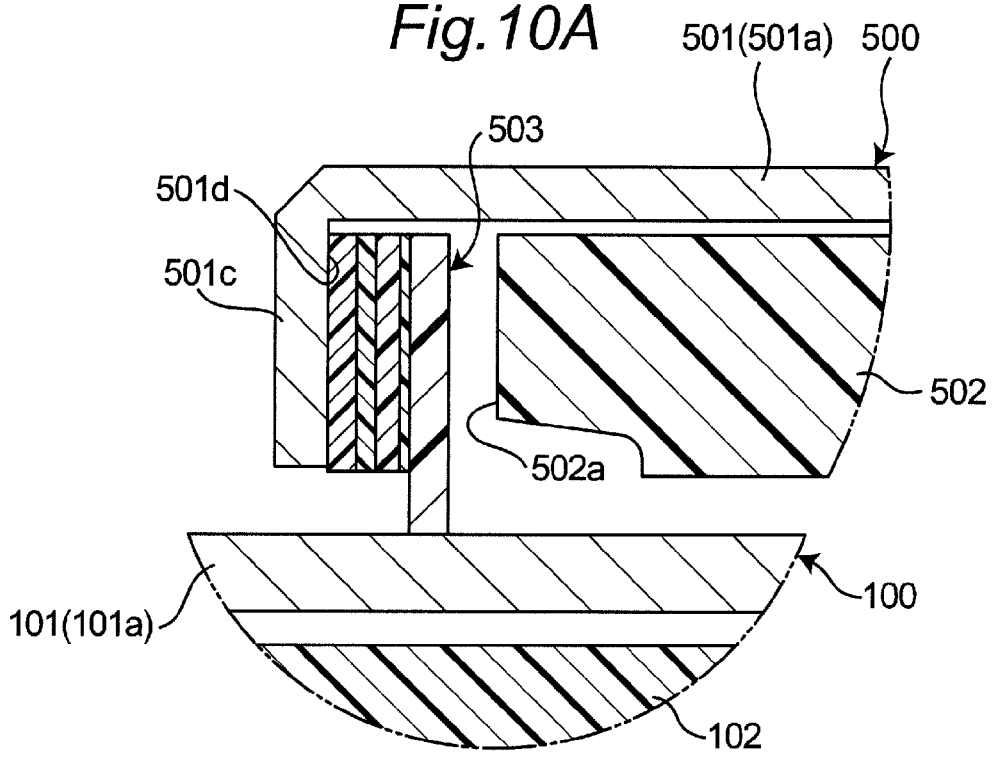


Fig.10B

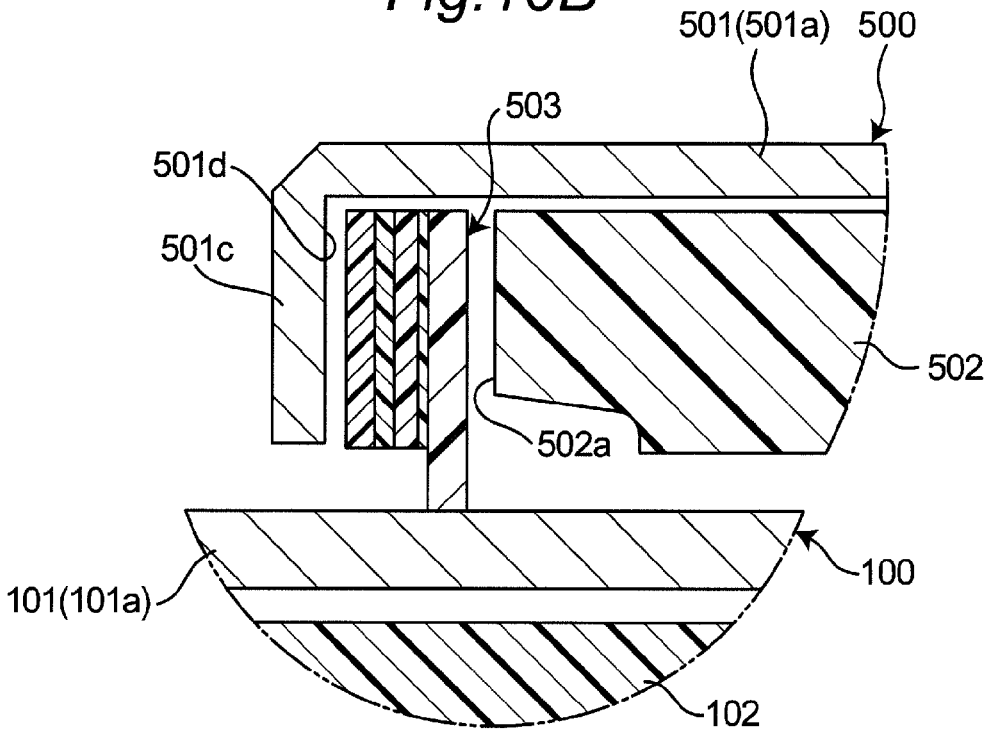


Fig.11

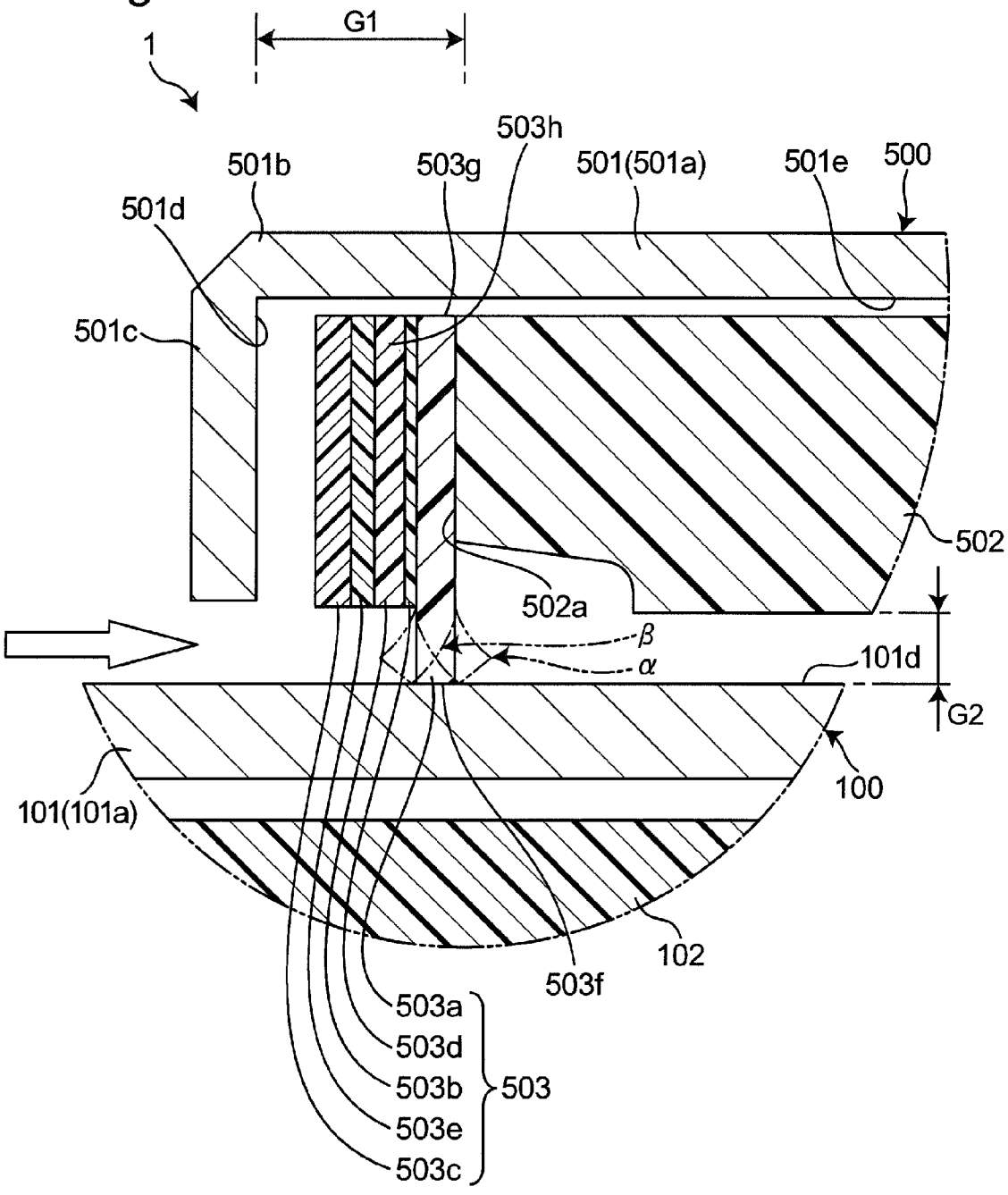

G1
1
503h
501b
503g
501(501a)
501e
500
501d
501c
502
502a
β
α
101d
G2
100
101(101a)
102
503f
503a
503d
503b
503
503e
503c

Fig.12

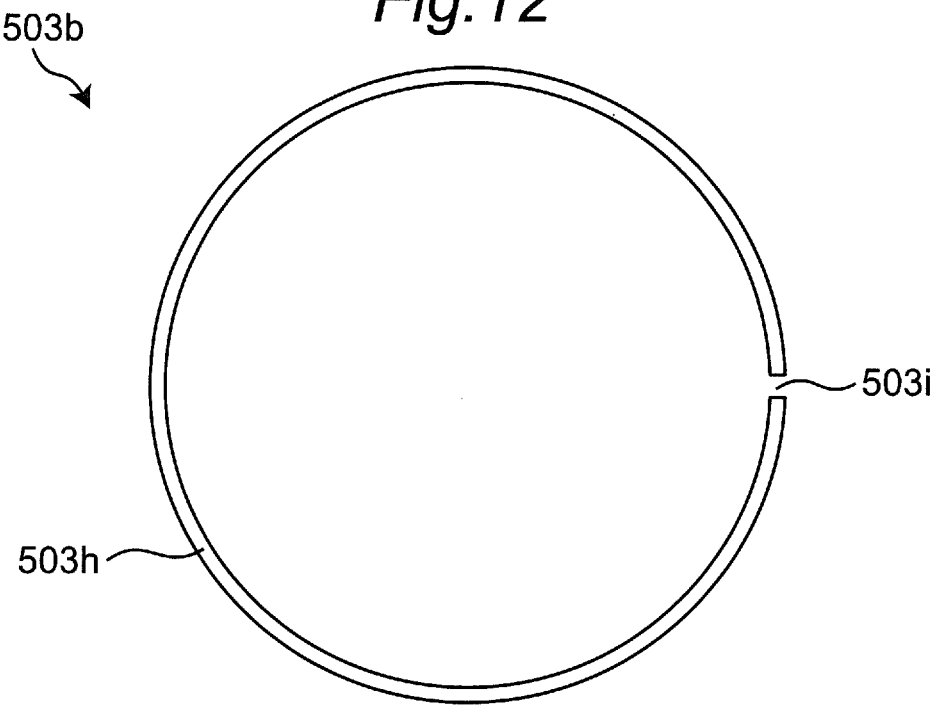
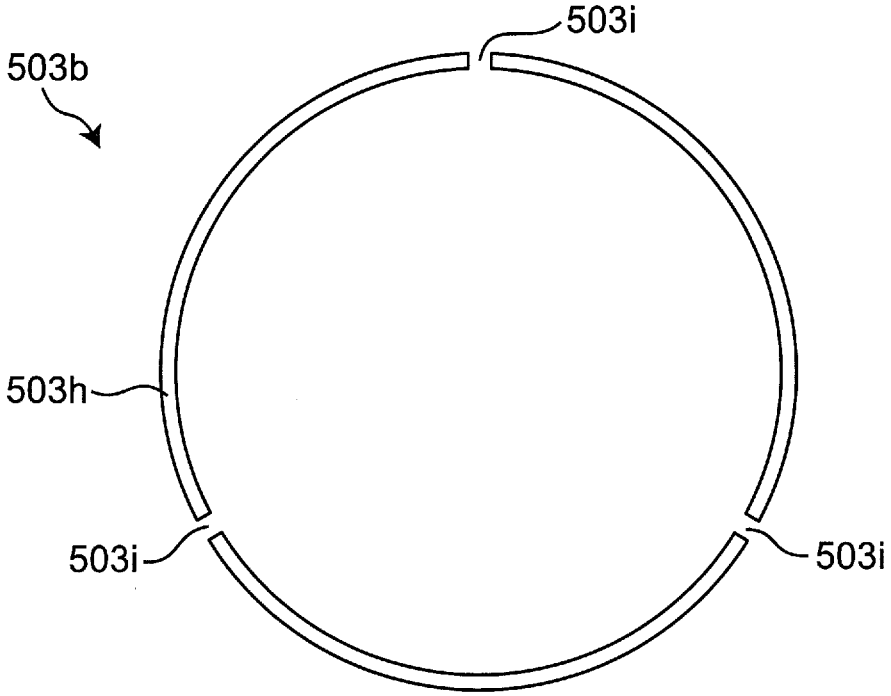


Fig.13



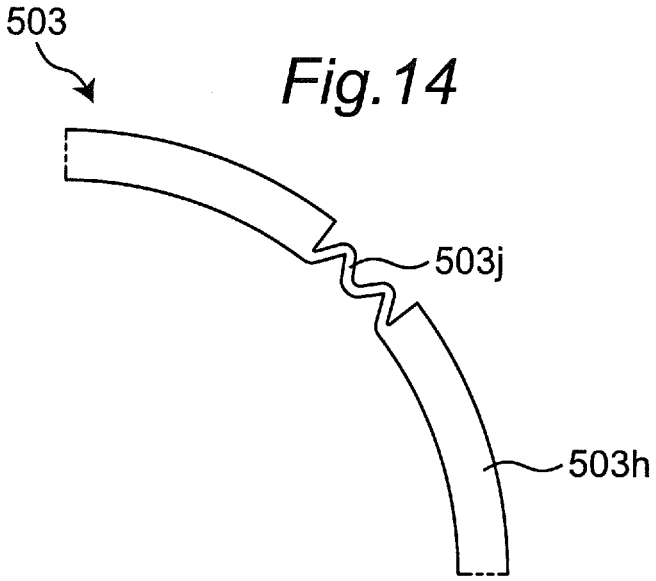


Fig.14

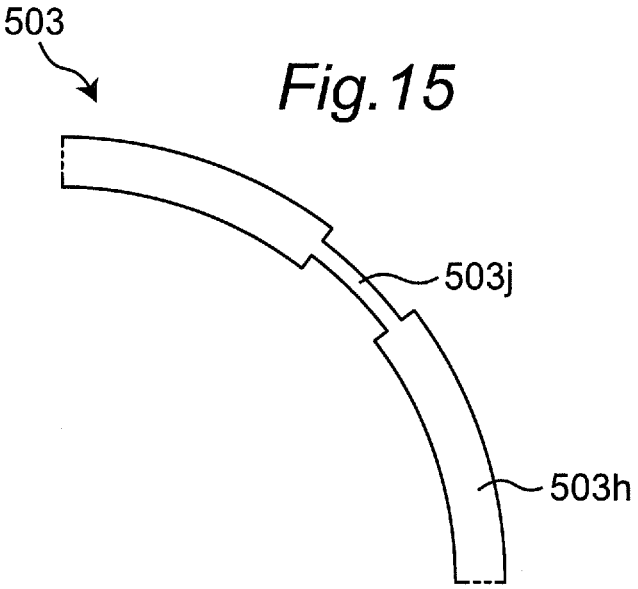
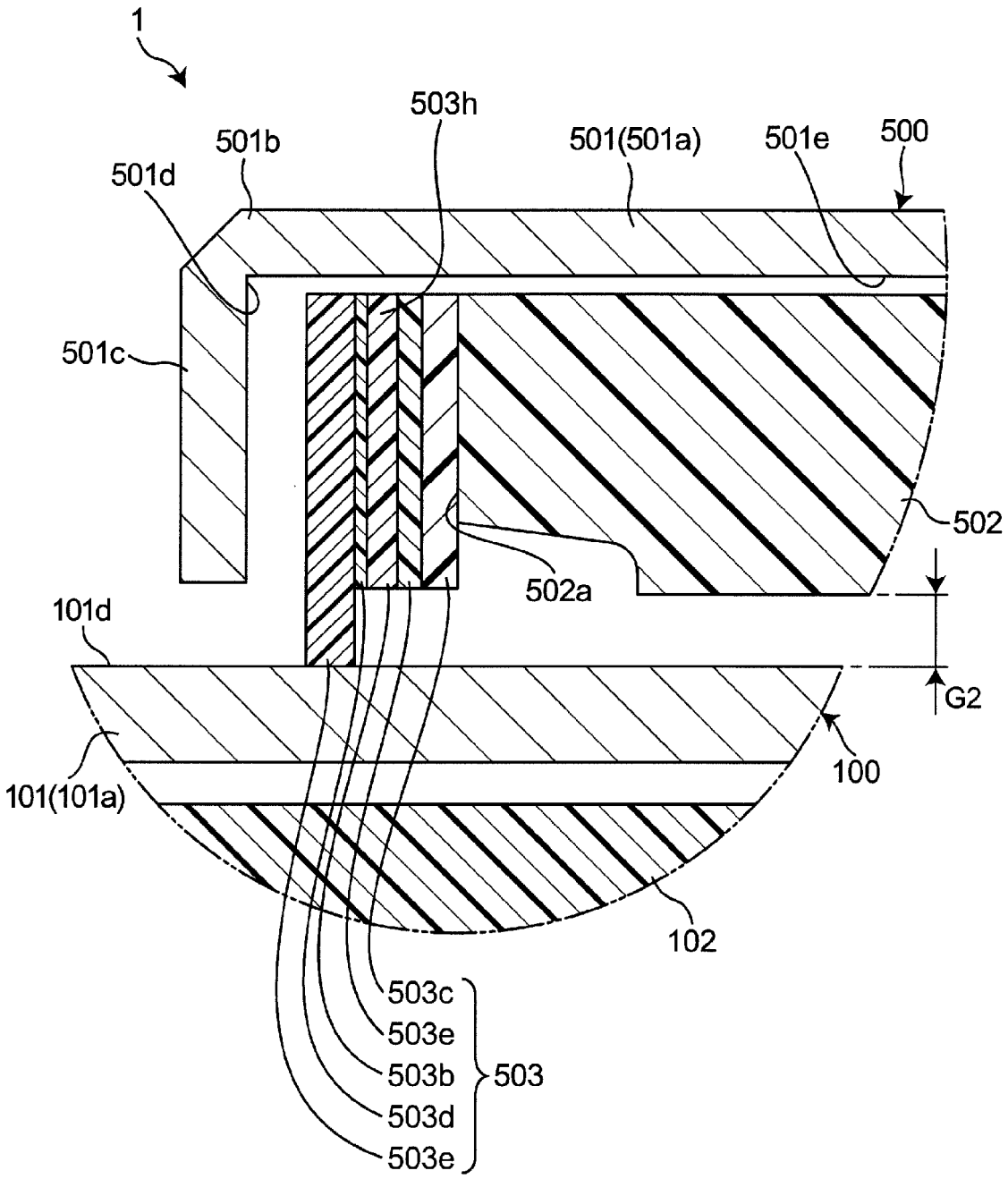


Fig.15

Fig.16


1
503h
501b
501(501a)
501e
500
501d
501c
502
502a
101d
G2
100
101(101a)
102
503c
503e
503b
503
503d
503e

LENS BARREL

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority of Japanese Patent Application No.: 2013-012840 filed on Jan. 28, 2013, the content of which is incorporated herein by reference.

BACKGROUND

1. Technical Field

The present invention relates to a lens barrel.

2. Description of Related Art

JP 2011-13613 A discloses a lens instrument provided with a lens barrel capable of being extended in three stages.

SUMMARY

It is an object of the present disclosure to provide a lens barrel having further improved quality. For example, the present disclosure relates to a technique of blocking the entrance of harmful light into the lens barrel through a gap formed between members which constitute the lens barrel.

The present disclosure provides a lens barrel comprising, a first barrel portion, a second barrel portion which is arranged inside the first barrel portion and is movable in an optical axis direction relative to the first barrel portion, and a light shielding member for light shielding between the first barrel portion and the second barrel portion, wherein the light shielding member comprises a light shielding layer with an endless ring shape which is slidably fitted on the second barrel portion and closes a gap defined between the first barrel portion and the second barrel portion and extending in a direction orthogonal to the optical axis direction, and a support layer including a body with endless-ring shape bonded to the light shielding layer and at least one low rigidity portion having rigidity lower than that of the body.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a lens barrel in a stored state;

FIG. **2** is a perspective view of the lens barrel in a wide angle state;

FIG. **3** is a perspective view of the lens barrel in a telescopic state;

FIG. **4** is an exploded perspective view of the lens barrel;

FIG. **5** is a cross-sectional view of the lens barrel in the telescopic state;

FIG. **6** is an enlarged view of an area VI in FIG. **5**;

FIG. **7** is a front view of a light shielding member;

FIG. **8** is a front view of a support layer;

FIG. **9** is an enlarged cross-sectional view taken along a line IX-IX in FIG. **7**;

FIG. **10**A is an enlarged cross-sectional view similar to FIG. **6** showing a state where the light shielding member abuts with an inwardly directed flange portion of a second decoration frame;

FIG. **10**B is an enlarged cross-sectional view similar to FIG. **6** showing a state where the light shielding member is positioned between an end portion of a first rectilinear frame and the inwardly directed flange portion of the second decoration frame;

FIG. **11** is an enlarged cross-sectional view similar to FIG. **6** showing a state where the light shielding member is likely to abut with the end portion of the first rectilinear frame;

FIG. **12** is a front view of a first alternative of the support layer;

FIG. **13** is a front view of a second alternative of the support layer;

FIG. **14** is a partially enlarged front view of a third alternative of the support layer;

FIG. **15** is a partially enlarged front view of a fourth alternative of the support layer;

FIG. **16** is an enlarged cross-sectional view similar to FIG. **6** showing an alternative of the light shielding member.

DETAILED DESCRIPTION

Hereinafter, an exemplary embodiment is explained in conjunction with drawings.

FIGS. **1** to **5** show a lens barrel **1** according to an embodiment. The lens barrel **1** is preferably used in digital cameras. However, this disclosure is not limited to the digital cameras and is also applicable to a lens barrel used in various imaging devices including film cameras and video cameras.

[1. Schematic constitution of lens barrel **1**]

As shown in FIG. **4**, the lens barrel **1** includes a first lens unit **100**, a second lens unit **200**, a third lens unit **300**, a fourth lens unit **400**, a first rectilinear unit **500**, a cam barrel **600**, a second rectilinear frame **700**, a second rectilinear unit **800**, a drive frame **900**, a fixing frame **1000**, a master flange unit **1100**, a zoom unit **1200**, a focusing unit **1400**, and an imaging element unit **1300**, and a focusing unit **1400**. Axes of these parts are substantially aligned with an optical axis AX.

In the following explanation, a direction parallel to the optical axis AX is referred to as an optical axis direction and a direction perpendicular to the optical axis AX is referred to as a radial direction. A direction along a circle about the optical axis AX is referred to as a circumferential direction. Further, a side where an object to be imaged is arranged in the optical axis direction is referred to as a front side or a front surface side, and an anti-side opposite to the side where the object to be imaged is arranged in the optical axis direction (an imaging element **1301** side) is referred to as a rear side or a back surface side. A term "cam mechanism" means a structure where one element of two relevant elements includes a cam and the other element includes a cam follower. A term "bayonet mechanism" means the structure where two relevant elements are connected to each other in a state where the elements are rotatable relative to each other but are not linearly movable relative to each other. A term "rectilinear mechanism" means the structure where two relevant elements are connected to each other in a state where the elements are linearly movable relative to each other but are not rotatable relative to each other.

The first lens unit **100** includes a first group lens frame **102** and a first decoration frame **101** both of which have a cylindrical shape. The first group lens frame **102** holds a first lens group L**1** which is positioned on a side closest to the object to be imaged. The first decoration frame **101** includes a cylindrical portion **101***a* and an end portion **101***b* which closes a front side of the cylindrical portion **101***a*. An aperture portion **101***c* which allows an effective light to pass therethrough is formed on the end portion **101***b*. The first decoration frame **101** is fixed to the first group lens frame **102** in a state where the first decoration frame **101** covers the first group lens frame **102**.

The second lens unit **200** includes a second group lens frame **202** which holds a second lens group L**2** for zooming.

The third lens unit **300** includes a third group lens frame **301** and a shutter frame **302**. The third group lens frame **301** holds a third lens group L**3** for correction. The third group

lens frame **301** moves in the radial direction between a position where the third lens group L**3** is arranged on the optical axis AX and a position where the third lens group L**3** is retracted from the optical axis AX. The shutter frame **302** incorporates a shutter mechanism therein.

The fourth lens unit **400** includes a fourth group lens frame **401** which holds a fourth lens group L**4** for focusing. The fourth group lens frame **401** is driven by the focusing unit **1400** and moves in the optical axis direction.

The first rectilinear unit **500** includes a first rectilinear frame **502** and a second decoration frame **501** both of which are formed in a cylindrical shape with substantially opened both ends. The second decoration frame **501** is fixed to the first rectilinear frame **502** in a state where the second decoration frame **501** covers a radially outer side of the first rectilinear frame **502**. Further, the first rectilinear unit **500** includes a light shielding member **503** described in detail later.

The second rectilinear unit **800** includes a third rectilinear frame **802** and a third decoration frame **801**. The third decoration frame **801** is fixed to the third rectilinear frame **802** in a state where the third decoration frame **801** covers a radially outer side of the third rectilinear frame **802**. Further, the second rectilinear unit **800** includes a light shielding member **803**.

The master flange unit **1100** is fixed to a back surface of the fixing frame **1000**. The imaging element unit **1300** is fixed to a back surface of the master flange unit **1100**. The imaging element unit **1300** includes a CCD-type or a COMS-type imaging element **1301** for example.

The second rectilinear unit **800** is arranged inside the fixing frame **1000** in the radial direction. The drive frame **900** is arranged inside the second rectilinear unit **800** in the radial direction. The drive frame **900** is rotatably driven in the circumferential direction by the zoom unit **1200** via a gear **1001**. A cam mechanism is provided between the drive frame **900** and the fixing frame **1000**. Accordingly, the drive frame **900** moves rectilinearly in the optical axis direction while being rotated in the circumferential direction due to a drive force of the zoom unit **1200**. The third rectilinear frame **802** of the second rectilinear unit **800** is connected to the drive frame **900** by a bayonet mechanism. A rectilinear mechanism is provided between the third rectilinear frame **802** and the fixing frame **1000**. Accordingly, the second rectilinear unit **800** moves rectilinearly together with the drive frame **900** but does not rotate in the circumferential direction.

The first rectilinear unit **500** is arranged inside the second rectilinear unit **800** in the radial direction. The cam barrel **600** is arranged inside the first rectilinear unit **500** in the radial direction. The second rectilinear frame **700** is arranged inside the cam barrel **600** in the radial direction. The second lens unit **200** and the third lens unit **300** are arranged inside the second rectilinear frame **700** in the radial direction.

A cam mechanism is provided between the first rectilinear frame **502** of the first rectilinear unit **500** and the drive frame **900**. Further, a rectilinear mechanism is provided between the first rectilinear frame **502** and the third rectilinear frame **802** of the second rectilinear unit **800**. Accordingly, the first rectilinear frame **502** moves rectilinearly in the optical axis direction along with the rotation of the drive frame **900** but does not rotate in the circumferential direction.

A rectilinear mechanism is provided between the cam barrel **600** and the drive frame **900**. The cam barrel **600** is connected to the first rectilinear frame **502** of the first rectilinear unit **500** by a bayonet mechanism. Accordingly, the cam barrel **600** moves rectilinearly in the optical axis direction together with the first rectilinear frame **502** while rotating in the circumferential direction together with the drive frame **900**.

A rectilinear mechanism is provided between the second rectilinear frame **700** and the first rectilinear frame **502** of the first rectilinear unit **500**. The second rectilinear frame **700** is connected to the cam barrel **600** by a bayonet mechanism. Accordingly, the second rectilinear frame **700** moves rectilinearly in the optical axis direction together with the first rectilinear frame **502** but does not rotate in the circumferential direction.

A rectilinear mechanism is provided between the second lens frame **202** of the second lens unit **200** and the second rectilinear frame **700**. A cam mechanism is provided between the second group lens frame **202** and the cam barrel **600**. Accordingly, the second lens unit **200** moves rectilinearly in the optical axis direction along with the rotation of the cam barrel **600** but does not rotate in the circumferential direction.

A rectilinear mechanism is provided between the shutter frame **302** of the third lens unit **300** and the second rectilinear frame **700**. A cam mechanism is provided between the shutter frame **302** and the cam barrel **600**. Accordingly, the shutter frame **302** moves rectilinearly in the optical axis direction along with the rotation of the cam barrel **600** but does not rotate in the circumferential direction.

The first lens unit **100** is arranged inside the first rectilinear unit **500** in the radial direction. A rectilinear mechanism is provided between the first group lens frame **102** of the first lens unit **100** and the first rectilinear frame **502** of the first rectilinear unit **500**. A cam mechanism is provided between the first group lens frame **102** and the cam barrel **600**. Accordingly, the first lens unit **100** moves rectilinearly in the optical axis direction along with the rotation of the cam barrel **600** but does not rotate in the circumferential direction.

With reference to FIGS. **1** to **3**, the first lens unit **100**, the first rectilinear unit **500** and the second rectilinear unit **800** are extended in the optical axis direction in three stages from the fixing frame **1000**.

FIG. **1** shows a collapsed state (accommodated state) of the lens barrel **1**. Due to the engagement of the constitutional parts, a state of the lens barrel **1** is changed to a wide angle state shown in FIG. **2** from a state shown in FIG. **1**. Further, a state of the lens barrel **1** is changed to a telescopic state shown in FIG. **3** from a state shown in FIG. **2** corresponding to the engagement relationship of the constitutional parts. FIG. **5** also shows the lens barrel **1** in a telescopic state.

[2. First Lens Unit, First Rectilinear Unit, and Light Shielding Member]

With reference to FIG. **6**, as described previously, the first lens unit (second cylindrical portion) **100** is arranged inside the first rectilinear unit (first cylindrical portion) **500** in the radial direction.

In the first lens unit **100**, the first decoration frame (second outer frame) **101** is fixed to the first group lens frame (second cylindrical frame) **102**. With further reference to FIG. **4**, the cylindrical portion **101***a* of the first decoration frame **101** is arranged outside the first group lens frame **102** in the radial direction and surrounds the first group lens frame **102** so as to form a gap between the first group lens frame **102** and the first decoration frame **101**. The end portion **101***b* of the first decoration frame **101** is positioned in front of the first group lens frame **102** in the optical axis direction. A mechanism **103** (shown in FIG. **4**) for opening and closing the aperture portion **101***c* of the first decoration frame is provided in a space defined between the first group lens frame **102** and the end portion **101***b* of the first decoration frame **101**.

In the first rectilinear unit **500**, the second decoration frame (first outer frame) **501** is fixed to the first rectilinear frame (first cylindrical frame) **502**. The second decoration frame **501** includes a cylindrical portion (cylindrical body) **501***a* with opened both ends. An end portion **501***b* of the cylindrical portion **501***a* on a front side in the optical axis direction is positioned in front of an end portion **502***a* of the first rectilinear frame **502** on a front side in the optical axis direction. An inwardly directed flange portion **501***c* inwardly projects toward the first decoration frame **101** of the first lens unit **100** from the end portion **501***b* of the cylindrical portion **501***a* on a front side in the optical axis direction. The cylindrical portion **501***a* of the second decoration frame **501** is arranged outside the first rectilinear frame **502** in the radial direction and surrounds the first rectilinear frame **502** so as to form a gap between the first rectilinear frame **502** and the second decoration frame **501**. Further, a gap G1 extending in the optical axis direction is formed between the inwardly directed flange portion **501***c* of the second decoration frame **501** and the end portion **502***a* of the first rectilinear frame **502**.

A gap G2 extending in the radial direction is formed between an inner peripheral side of the first rectilinear unit **500** and an outer peripheral side of the first lens unit **100** such that the first lens unit **100** can move rectilinearly (advance and retract) in the optical axis direction relative to the first rectilinear unit **500**. The gap G2 has an endless ring shape having an approximately fixed width as viewed in the optical axis direction. As shown in FIG. **6**, in order to prevent or suppress the incidence of an external light (harmful light) into the inside of the lens barrel **1** from the gap G2, the first rectilinear unit **500** includes a light shielding member **503**.

With further reference to FIGS. **7** and **9**, the light shielding member **503** has an endless ring shape having an approximately fixed width. A thickness (a size in the optical axis direction) of the light shielding member **503** is set sufficiently smaller than a width (a size in the radial direction) of the light shielding member **503**. In other words, the light shielding member **503** has an endless ring shape having a small thickness.

As shown in FIG. **6**, the light shielding member **503** is arranged in a state where the light shielding member **503** surrounds an outer peripheral surface **101***d* of the first decoration frame **101** of the first lens unit **100**. Further, the light shielding member **503** is arranged in the gap G1 extending in the optical axis direction between the inwardly directed flange portion **501***c* of the second decoration frame **501** and the first rectilinear frame **502**. Further, the light shielding member **503** is arranged between a rear surface **501***d* of the inwardly directed flange portion **501***c* of the second decoration frame **501** and the end portion **502***a* of the first rectilinear frame **502** on a front side in the optical axis direction.

The light shielding member **503** of this embodiment includes a light shielding layer **503***a*, a support layer **503***b*, and a buffer layer **503***c*. The light shielding layer **503***a*, the support layer **503***b*, and the buffer layer **503***c* are arranged in this order in the direction toward a front side in the optical axis direction from the end portion **502***a* of the first rectilinear frame **502** on the front side in the optical axis direction. Accordingly, the light shielding layer **503***a* positioned on a rearmost side in the optical axis direction oppositely faces the end portion **502***a* of the first rectilinear frame **502**, and the buffer layer **503***c* positioned on a frontmost side in the optical axis direction oppositely faces the rear surface **501***d* of the inwardly directed flange portion **501***c* of the second decoration frame **501**.

The light shielding layer **503***a* and the support layer **503***b* are bonded to each other by a first bonding layer **503***d*. The support layer **503***b* and the buffer layer **503***c* are bonded to each other by a second bonding layer **503***e*. Thus, the light shielding layer **503***a* is bonded to a surface of the support layer **503***b* on a rear side in the optical axis direction with the first bonding layer **503***d* interposed therebetween, and the buffer layer **503***c* is connected to a surface of the support layer **503***b* on a front side in the optical axis direction with the second bonding layer **503***e* interposed therebetween. The first and second bonding layers **503***d* and **503***e* may be made of an adhesive agent or may be formed of a sheet which is provided with a layer made of an adhesive agent on both surfaces thereof.

As shown in FIG. **7**, the light shielding layer **503***a* has an endless ring shape and has a fixed width. The light shielding layer **503***a* is slidably fitted on the outer peripheral surface **101***d* of the first decoration frame **101**. As shown in FIG. **6**, the light shielding layer **503***a* closes the gap G2 extending in the radial direction between the first rectilinear unit **500** and the first lens unit **100**. A harmful light which intends to enter the inside of the lens barrel **1** from the gap G2 is blocked by the light shielding layer **503***a*.

An inner diameter of the light shielding layer **503***a* is set equal to an outer diameter of the first decoration frame **101** or is set slightly smaller than the outer diameter of the first decoration frame **101**. Therefore, an inner peripheral edge **503***f* of the light shielding layer **503***a* is substantially closely contacted to the outer peripheral surface **101***d* with deforming outward in the radial direction. Accordingly, the light shielding layer **503***a* is preferably made of a material with relatively low rigidity, that is, a material having low hardness and a small elastic modulus. This can suppress increasing of a contact friction load between the inner peripheral edge **503***f* and the outer peripheral surface **101***d* even when the inner peripheral edge **503***f* of the light shielding layer **503***a* is closely contacted with the outer peripheral surface **101***d* of the first decoration frame **101**, thereby increasing crossness degree. On the other hand, an outer diameter of the light shielding layer **503***a* is set such that an outer peripheral edge **503***g* of the light shielding layer **503***a* oppositely faces an inner peripheral surface **501***e* of the cylindrical portion **501***a* of the second decoration frame **501** with a gap. Accordingly, when the first lens unit **100** moves rectilinearly in the optical axis direction relative to the first rectilinear unit **500**, due to the contact friction between an inner peripheral edge **503***f* of the light shielding layer **503***a* and the outer peripheral surface **101***d* of the first decoration frame **101**, the light shielding member **503** moves in the optical axis direction together with the first lens unit **100**. Specifically, the light shielding member **503** moves between the position at which the light shielding member **503** is brought into contact with the end portion **502***a* of the first rectilinear frame **502** as shown in FIG. **6** and the position at which the light shielding member **503** is brought into contact with the inwardly directed flange portion **501***c* of the second decoration frame **501** as shown in FIG. **10**A. Depending on the position of the first lens unit **100** relative to the first rectilinear unit **500** in the optical axis direction, as shown in FIG. **10**B, the light shielding member **503** is positioned between the end portion **502***a* of the first rectilinear frame **502** and the inwardly directed flange portion **501***c* of the second decoration frame **501**.

As shown in FIG. **6**, there may be a case where the first lens unit **100** further moves rearward in the optical axis direction (toward a right side in FIG. **6**) in a state where the light shielding member **503** is brought into contact with the end portion **502***a* of the first rectilinear frame **502** (at the time of storing the first lens unit **100**). In this case, the outer peripheral surface **101***d* of the first decoration frame **101** moves

while maintaining a contact state with the inner peripheral edge **503***f* of the light shielding layer **503***a* or while being intermittently brought into contact with the inner peripheral edge **503***f* of the light shielding layer **503***a*. Accordingly, a state where the light shielding member **503** is brought into contact with the end portion **502***a* of the first rectilinear frame **502** is maintained.

As shown in FIG. **10**A, there may be a case where the first lens unit **100** further moves frontward in the optical axis direction (toward a left side in FIG. **10**A) in a state where the light shielding member **503** is brought into contact with the inwardly directed flange portion **501***c* of the second decoration frame **501** (at the time of extending the first lens unit **100**). Also in this case, the outer peripheral surface **101***d* of the first decoration frame **101** moves while maintaining a contact state with the inner peripheral edge **503***f* of the light shielding layer **503***a* or while being intermittently brought into contact with the inner peripheral edge **503***f* of the light shielding layer **503***a*. Accordingly, the light shielding member **503** is maintained in a state where the light shielding member **503** is brought into contact with the inwardly directed flange portion **501***c* of the second decoration frame **501**.

In this embodiment, the light shielding layer **503***a* is constituted by forming a layer with non-transparent property or light shielding property on a film made of polyethylene terephthalate (PET).

With reference to FIGS. **6** to **9**, the support layer **503***b* includes a body **503***h* and two slits **503***i* which are one example of a low-rigidity portion. The body **503***h* of the support layer **503***b* has a shape formed by substantially dividing a ring into two parts and has a fixed width. A thickness of the body **503***h* is sufficiently smaller than a width of the body **503***h*. In other words, the body **503***h* of the support layer **503***b* has a two-divided ring shape with a small thickness. An inner diameter of the body **503***h* of the support layer **503***b* is set sufficiently larger than the outer diameter of the first decoration frame **101**. Thus, an inner peripheral edge of the body **503***h* of the support layer **503***b* oppositely faces the outer peripheral surface **101***d* of the first decoration frame **101** with a sufficiently large gap therebetween and maintains a non-contact state with the outer peripheral surface **101***d* of the first decoration frame **101**.

The support layer **503***b* is provided for ensuring the rigidity of the whole light shielding member **503**. Accordingly, the body **503***h* of the support layer **503***b* is made of a material having a high rigidity, that is, a hard material with a large elastic modulus. Particularly, a material having higher rigidity and a larger elastic modulus than those of a material for forming the light shielding layer **503***a* and a material for forming the buffer layer **503***c* is preferably used as a material for forming the body **503***h* of the support layer **503***b*. This is because that insufficient rigidity of the light shielding member **503** can cause the light shielding layer **503***a* to be dragged out from the second decoration frame **501** along with the first lens unit **100** when the first lens unit **100** moves relative to the first rectilinear unit **500** in the optical axis direction. Forming the support layer **503***b* by the material with high rigidity, that is, by the hard material having the large elastic modulus can prevent the dragging out of the light shielding layer **503***a* from the second decoration frame **501** along with the first lens unit **100**. In this embodiment, the body **503***h* of the support layer **503***b* is made of a PET (Poly-Ethylene-Terephthahlate) resin. Besides PET, a material having an elastic modulus of approximately 1.0 to 500.0 GPa such as PC (Polycarbonate), PS (Polystyrene), nylon, acrylic, polyimide, an aluminum alloy, iron or stainless steel can be used as a material for forming the support layer **503***b*.

As shown in FIG. **8** most clearly, the slit **503***i* is formed in two portions of the body **503***h* of the support layer **503***b* which are symmetrical with respect to a center of the body **503***h* when the body **503***h* is viewed in the optical axis direction. The body **503***h* is divided at portions where the slit **503***i* is formed.

With reference to FIGS. **6**, **7**, and **9**, the buffer layer **503***c* has an endless ring shape and has a fixed width. A thickness of the buffer layer **503***c* is sufficiently smaller than a width of the buffer layer **503***c*. In other words, the buffer layer **503***c* has an endless ring shape with a small thickness. An inner diameter of the buffer layer **503***c* is set sufficiently larger than the outer diameter of the first decoration frame **101**. Thus, an inner peripheral edge of the buffer layer **503***c* oppositely faces the outer peripheral surface **101***d* of the first decoration frame **101** with a sufficient gap therebetween, and maintains a non-contact state where an inner peripheral edge of the buffer layer **503***c* is not brought into contact with the outer peripheral surface **101***d* of the first decoration frame **101**. It should be noted that although the inner peripheral edge of the buffer layer **503***c* oppositely faces the outer peripheral surface **101***d* of the first decoration frame **101**, other arrangement can be applied. Similarly to the light shielding layer **503***a*, the inner peripheral edge of the buffer layer **503***c* can maintain a contact state with or be intermittently brought into contact with the outer peripheral surface **101***d* of the first decoration frame **101**. In such cases, an amount of the blocked harmful light intending to enter the lens barrel **1** through the gap G2 is increased.

When the first lens unit **100** moves frontward in the optical axis direction relative to the first rectilinear unit **500**, the light shielding member **503** is brought into contact with the rear surface **501***d* of the inwardly directed flange portion **501***c* of the second decoration frame **501**. The buffer layer **503***c* is provided for absorbing or buffering an impact generated when the light shielding member **503** is brought into contact with the inwardly directed flange portion **501***c* as well as vibrations caused by such an impact. Accordingly, the buffer layer **503***c* is made of a material having a low rigidity, that is, a soft material having a small elastic modulus and a relatively high viscosity. In this embodiment, the buffer layer **503***c* is manufactured using neoprene rubber. Besides the neoprene rubber, a material having an elastic modulus of approximately 0.001 to 0.2 GPa and having a relatively high viscosity such as other rubbers, elastomer, foamed urethane, or foamed polymer can be used as material for manufacturing the buffer layer **503***c*.

Assuming that the light shielding member **503** does not include the buffer layer **503***c*, when the first lens unit **100** moves frontward in the optical axis direction relative to the first rectilinear unit **500**, the support layer **503***b* is brought into contact with the inwardly directed flange portion **501***c*. In this case, because the support layer **503***b* is made of a material having a high rigidity, that is, a hard material having with a large elastic modulus as described previously, the light shielding member **503** suffers from a small effect of suppressing an impact generated when the support layer **503***b* is brought into contact with the inwardly directed flange portion **501***c* and of suppressing vibrations caused by such an impact (small damper effect). As a result, noises are easily to be generated due to vibrations of the light shielding member **503**. Contrarily to this, in this embodiment, because the buffer layer **503***c* made of a material having a small elastic modulus and high viscosity is brought into contact with the rear surface **501***d* of the inwardly directed flange portion **501***c* as described above,

a damper effect of suppressing vibrations can be acquired whereby noises caused by vibrations of the light shielding member **503** can be effectively suppressed.

On the other hand, a conventional light shielding member is a ring member and at least has a light shielding layer made of a material such as rubber material, a bonding layer, and a support layer made of a material such as a PET resin and not having a low rigidity portion such as a slit. These layers are staked form the rear side in the optical axis direction in this order. Because an inner configuration of the light shielding member contacts with an outer configuration of a barrel which is inwardly engaged with the inner configuration of the light shielding member, movement of the barrel can cause vibrations and swinging when a movement direction of the light shielding member is reversed, that is, when transition between a state indicated by a symbol a in FIG. **11** and a state indicated by a symbol β in FIG. **11** is occurred. In the above conventional configuration, abnormal noises can be caused due to the vibrations or the swinging. Particularly, the more larger an outer diameter of the first decoration frame **101** is and the more smaller an inner diameter of the light shielding layer **503***a* is, by manufacturing size dispersion, the more easily the abnormal noise is generated.

When the first lens unit **100** moves rearward in the optical axis direction relative to the first rectilinear unit **500**, the light shielding member **503** is brought into contact with the end portion **502***a* of the first rectilinear frame **502** of the first rectilinear unit **500** on a front side in the optical axis direction (see FIG. **6**). By adopting the light shielding member **503** of this embodiment, noises when the light shielding member **503** is brought into contact with the end portion **502***a* of the first rectilinear frame **502** can be effectively suppressed. The reason the noises can be effectively suppressed is explained hereinafter.

Assuming that the slits **503***i* are not formed in the support layer **503***b* of the light shielding member **503**, the rigidity of the light shielding member **503** is excessively increased. In other words, the level of the rigidity of the light shielding member **503**, that is, the level of the rigidity substantially determined by the support layer **503***b*, is sufficient as long as the light shielding layer **503** is not dragged out from the second decoration frame **501** along with the first lens unit **100**. However, in case that the slit **503***i* is not formed in the support layer **503***b* of the light shielding member **503**, the rigidity exceeds such level. Therefore, when the light shielding member **503** is brought into contact with the end portion **502***a* of the first rectilinear frame **502** on a front side in the optical axis direction, as indicated by the symbol a in FIG. **11**, due to a contact friction between the inner peripheral edge **503***f* of the light shielding layer **503***a* and the outer peripheral surface **101***d* of the cylindrical portion **101***a* of the first decoration frame **101**, an inner peripheral side of the light shielding layer **503***a* is elastically deflected rearward in the optical axis direction. The inner peripheral side of the light shielding layer **503***a* which is elastically deflected rearward in the optical axis direction is elastically deflected frontward in the optical axis direction immediately as indicated by the symbol β in FIG. **11** due to elasticity which the light shielding layer **503***a* per se possesses. Since the inner peripheral side of the light shielding layer **503***a* is instantaneously and continuously deflected rearward and frontward in the optical axis direction, that is, revised as described above, the light shielding layer **503***a* collides with the end portion **502***a* of the first rectilinear frame **502**. The light shielding member **503** vibrates due to an impact generated at the time of such collision and hence, noises are liable to be generated.

Contrarily to this, in this embodiment, the low rigidity portion such as the slits **503***i* is formed in the support layer **503** so that the rigidity of the support layer **503***b* is adjusted such that the rigidity of the support layer **503***b* is not excessively increased. Accordingly, it is possible to prevent the phenomenon that, when the light shielding member **503** is brought into contact with the end portion **502***a* of the first rectilinear frame **502**, the inner peripheral side of the light shielding layer **503***a* is deflected and is brought into contact with the end portion **502***a*. Even in case that the low rigidity portion such as the slit **503***i* in the support layer **503***b* of the light shielding member **503**, the level of rigidity necessary for preventing the light shielding layer **503***a* from being dragged out from the second decoration frame can be maintained. The low rigidity portion such as the slit **503***i* formed in the support layer **503***b* of the light shielding member **503** allows the light shielding member **503** to easily expand in the radial direction. In other words, the low rigidity portion such as the slit **503***i* formed in the support layer **503***b* of the light shielding member **503** decreases a force necessary for the expansion of the light shielding member **503** in the radial direction, resulting in that the contact friction load between the inner peripheral edge **503***f* of the light shielding layer **503***a* and the outer peripheral surface **101***d* of the first decoration frame **101** is suppressed even in case of that the inner peripheral edge **503***f* of the light shielding layer **503***a* and the outer peripheral surface **101***d* of the first decoration frame **101** are closely contacted with each other. The equilibrium between the force that outwardly expands the light shielding member and a restorative fore that tends to restore the light shielding member to the original shape stabilizes the contact condition between the first light shielding member **503** and the first decoration frame **101**. Thus, even in case of large manufacturing size dispersion, generation of noises can be suppressed. As a result, it is possible to effectively suppress the generation of vibrations of the light shielding member **503** caused by the collision of the light shielding layer **503***a* with the end portion **502***a* of the first rectilinear frame **502** and the generation of noises caused by such vibrations.

In case that the support layer **503***b* is made of a material with low rigidity, that is, a soft material with small elastic modulus similar to a material for forming the buffer layer **503***c* as described above, there exists the following problem. It is assumed a state where the light shielding member **503** is brought into contact with the inwardly directed flange portion **501***c* of the second decoration frame **501** as shown in FIG. **10**A. In this state, when the first lens unit **100** moves frontward in the optical axis direction relative to the first rectilinear unit **500**, due to the insufficient rigidity of the light shielding member **503**, the light shielding layer **503***a* is dragged out to the outside of the second decoration frame **501** along with the first lens unit **100**.

Contrarily to this, the support layer **503** of this embodiment ensures the required rigidity for preventing the dragging out of the support layer **503** although the rigidity is adjusted by forming the slits **503***i* in the support layer **503***b*. Accordingly, there is no possibility that light shielding layer **503***a* is dragged out from the second decoration frame **501** along with the first lens unit **100**.

As has been explained heretofore, by forming the slits **503***i* in the support layer **503***b*, it is possible to surely prevent the light shielding layer **503***a* from being pulled out to the outside of the second decoration frame **501** while effectively suppressing the generation of noises.

FIGS. **12** to **15** show alternatives of the support layer **503***b*.

A support layer **503***b* shown in FIG. **12** includes a single slit **503***i*. A support layer **503***b* shown in FIG. **13** includes three

slits **503***i* which are arranged at equal angular intervals with respect to the center of the support layer **503***b* as viewed in the optical axis direction. Three or more slits may be formed on the support layer **503***b*.

Each of the support layers **503***b* shown in FIGS. **14** and **15** includes, in place of the slit, a narrow width portion **503***j* where a width of a portion of a body **503***h* of the support layer **503** is set smaller than widths of other portions of the body **503***h* of the support layer **503**. In FIG. **14**, the narrow width portion **503***j* has a meandering shape. In FIG. **15**, the narrow width portion **503***j* has a circular-arcuate shape and has the center in common with the body **503***h*. The narrow width portion **503***j* functions as the low rigidity portion and thereby achieves similar effects as those of the slit. Further, although not illustrated, in place of the slit, it can be provided a thin thickness portion at which the thickness in the optical axis direction of the body **503***h* of the support layer **503** is partially set to smaller than that of the other portion of the body **503***h*. Such structure can also achieve similar effects.

FIG. **16** shows an alternative of the light shielding member **503**. In this light shielding member **503**, a buffer layer **503***c*, a support layer **503***b*, and a light shielding layer **503***a* are arranged in this order in the direction from an end portion **502***a* of a first rectilinear frame **502** on the front side in the optical axis direction toward a front side in the optical axis direction. Accordingly, the buffer layer **503***c* positioned on a rearmost side in the optical axis direction oppositely faces an end portion **502***a* of the first rectilinear frame **502**, and the light shielding layer **503***a* positioned on a frontmost side in the optical axis direction faces the inwardly directed flange portion **501***c* of a second decoration frame **501**. Such structure can also achieve similar effects.

A material for forming the light shielding layer **503***a* may be equal to a material for forming the buffer layer **503***c*. Thus, as a material for forming the light shielding layer **503***a*, it is possible to use a material having an elastic modulus of approximately 0.001 to 0.2 GPa and having a relatively high viscosity such as rubber represented by neoprene rubber, elastomer, foamed urethane, or foamed polymer.

Although the present disclosure has been fully described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Such changes and modifications are to be understood as included within the scope defined by the appended claims unless they depart therefrom.

What is claimed is:

1. A lens barrel comprising:
- a first barrel portion;
- a second barrel portion which is arranged inside the first barrel portion and is movable in an optical axis direction relative to the first barrel portion; and
- a light shielding member for light shielding between the first barrel portion and the second barrel portion,
- wherein the light shielding member comprises:
- a light shielding layer with an endless ring shape which is slidably fitted on the second barrel portion and closes a gap defined between the first barrel portion and the second barrel portion and extending in a direction orthogonal to the optical axis direction;
- a support layer including a body with a shape corresponding to that of the light shielding layer bonded to the light shielding layer and at least one low rigidity portion having rigidity lower than that of the body; and
- a buffer layer bonded to a side of the support layer opposite to the light shielding layer.

2. The lens barrel according to claim **1**, wherein the low rigidity portion is a slit which divides the support layer into a plurality of the bodies.

3. The lens barrel according to claim **1**, wherein the low rigidity portion is a narrow width portion having a width narrower than that of the body.

4. The lens barrel according to claim **3**, wherein the narrow width portion has a meandering shape.

5. The lens barrel according to claim **1**, wherein the narrow width portion has a thickness smaller than that of the body.

6. The lens barrel according to claim **1**, wherein the first barrel portion includes:
- a first cylindrical frame; and
- a first outer frame including:
- a cylindrical body which is fixed to the first cylindrical frame, surrounds an outer periphery of the first cylindrical frame, and has a front-side end portion in the optical axis direction, the front-side end portion being positioned in front of a front-side end portion of the first cylindrical frame in the optical axis direction in the optical axis direction; and
- an inwardly directed flange portion which projects inwardly from the front-side end portion of the cylindrical body in the optical axis direction,
- wherein the light shielding member is arranged in a gap in the optical axis direction defined between the front-side end portion of the first cylindrical frame and the inwardly directed flange portion.

7. The lens barrel according to claim **6**, wherein the second barrel portion includes:
- a second cylindrical frame; and
- a second outer frame which is fixed to the second cylindrical frame and surrounds an outer periphery of the second cylindrical frame,
- wherein the light shielding layer of the light shielding member is fitted on the second outer frame.

8. The lens barrel according to claim **7**, wherein the second barrel portion is a lens unit for holding a lens on a side closest to an object to be imaged, and
- wherein the first barrel portion is a rectilinear unit arranged outside the lens unit.

9. The lens barrel according to claim **8**, wherein the first cylindrical frame is a rectilinear frame and the first outer frame is a decoration frame for the rectilinear frame, and
- wherein the second cylindrical frame is a lens frame for holding the lens and the second outer frame is a decoration frame for the lens frame.

10. The lens barrel according to claim **9**, wherein the light shielding layer, the support layer, and the buffer layer are arranged in this order from the rectilinear frame toward the inwardly directed flange portion.

11. The lens barrel according to claim **9**, wherein the buffer layer, the support layer, and the light shielding layer are arranged in this order from the rectilinear frame toward the inwardly directed flange portion.

12. A lens barrel comprising:
- a first barrel portion;
- a second barrel portion which is arranged inside the first barrel portion and is movable in an optical axis direction relative to the first barrel portion; and
- a light shielding member for light shielding between the first barrel portion and the second barrel portion,
- wherein the light shielding member comprises:
- a light shielding layer with an endless ring shape which is slidably fitted on the second barrel portion and closes a gap defined between the first barrel portion and the sec-

ond barrel portion and extending in a direction orthogonal to the optical axis direction; and

a support layer including a body with a shape corresponding to that of the light shielding layer bonded to the light shielding layer and at least one low rigidity portion having rigidity lower than that of the body,

wherein the low rigidity portion is a narrow width portion having a width narrower than that of the body, and

wherein the narrow width portion has a meandering shape.

13. A lens barrel comprising:

a first barrel portion;

a second barrel portion which is arranged inside of the first barrel portion and is movable in an optical axis direction relative to the first barrel portion; and

a light shielding member for light shielding between the first barrel portion and the second barrel portion,

wherein the light shielding member comprises:

a light shielding layer which is slidably fitted on the second barrel portion and closes a gap defined between the first barrel portion and the second barrel portion and extending in a direction orthogonal to the optical axis direction;

a support layer which is bonded to the light shielding layer and has a shape corresponding to that of the light shielding layer; and

a buffer layer bonded to a side of the support layer opposite to the light shielding layer.

14. The lens barrel according to claim **13**, wherein elastic modulus of the light shielding layer and the buffer layer is smaller than that of the support layer.

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